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FUEL CELL
[Nenryo denchi]

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[Claims]

[Claim 1] A fuel cell comprising a fuel chamber equipped with a fuel supply route for supplying fuel to and discharging fuel from a fuel oxidation electrode, an air chamber equipped with an air supply route for supplying air to and discharging air from an air reduction electrode, and an electrolyte chamber between the fuel oxidation electrode and air reduction electrode equipped, respectively, with collector plates, wherein a slidable shutter plate with a plurality of through-holes formed therein is installed in the boundary section between at least one of the electrodes and the chamber adjacent thereto, being either the fuel chamber or air chamber, wherein the collector plates have the same number of through-holes as the shutter plate and have through-holes with a shape corresponding to the through-holes in the shutter plate, and wherein the collector plates are arranged so as to make contact with the shutter plate.

[Detailed Description of the Invention]

[0001] [Industrial Field of Application]

The present invention relates to a fuel cell and, more specifically, a fuel cell with high responsiveness to load fluctuations.

[0002] [Prior Art]

In a fuel cell, a fuel such as methanol is supplied, for example, to the negative electrode ("fuel oxidization electrode") and air is supplied to the positive electrode opposite the negative electrode ("air reduction electrode") via an electrolyte. At the fuel oxidation

electrode, the methanol fuel is reacted with water, generating CO_2 gas, protons, and electrons. The electrons generated by the fuel oxidation electrode are supplied to the load end via a collector plate.

[0003] At the air reduction electrode, the electrons supplied to the air reduction electrode via the load and the protons and air supplied from the electrolyte generate water.

[0004] By performing the combustion reaction of the methanol fuel electrochemically, the free energy fluctuation accompanying the oxidation reaction can be extracted as direct electric energy.

[0005] A detailed diagram of the electrodes is shown in FIG 5. The collector 39 and fuel oxidation electrode 33 consisting of a vapor fuel gas supply layer 33a and a fuel oxidation reaction layer 33b are adjacent to the fuel chamber 32. Similarly, a collector 39 and an air reduction electrode 36 consisting of a gas supply layer 36a and an air reduction reaction layer 36b are adjacent to the air chamber 37. The collector 39 consists of a metal mesh. The gas supply layers 33a, 36a for the electrodes 33, 36 are installed and adjusted so that methanol fuel does not reach the direct reaction layers 33b, 36b. This can be done, for example, using hydrophobic carbon clusters with a diameter of 400Å. The vapor fuel or air is reacted in the reaction layers 33b, 36b of the electrodes 33, 36. In order to improve the moisture properties with the electrolyte in the adjacent electrolyte chamber 35 (e.g., containing several dozen percent aqueous nitric acid solution), hydrophilic carbon clusters can be used. The oxidation reaction

catalyst for the fuel in the reaction layer 33b on the fuel chamber 32 end can be an alloy of Pt and Ru, and the air oxidation reaction catalyst in the reaction layer 36b on the air chamber 37 end can be Pt.

[0006] The gas supply layers 33a, 36a supply methanol gas or oxygen gas to the electrodes 33, 36 and keep the gas generated by the cell reaction in the reaction layers 33b, 36b from being discharged to the fuel chamber 32 end. The reaction layers 33b, 36b contain a catalyst to start the cell reaction.

[0007] [Problem Solved by the Invention]

A rear fuel supply-type fuel cell of the prior art can operate under normal conditions, but cannot handle load fluctuations. Load fluctuations are handled by controlling the concentration and quantity of fuel supplied, and large auxiliary devices are needed to handle control issues such as precision and responsiveness.

[0008] Also, the methanol fuel passes through the electrolyte chamber 35 and disperses in the air reaction electrode 36. When the cell reaction stops, a large amount of fuel disperses in the electrolyte chamber 35. This decreases cell performance at startup and generates heat.

[0009] Therefore, the purpose of the present invention is to provide a highly responsive fuel cell able to operate during load fluctuations, yet able to completely block permeation of the fuel into the electrolyte when the cell reaction stops.

[0010] [Means of Solving the Problem]

The present invention achieves this purpose with the following configuration. In other words, the present invention is a fuel cell comprising a fuel chamber equipped with a fuel supply route for supplying fuel to and discharging fuel from a fuel oxidation electrode, an air chamber equipped with an air supply route for supplying air to and discharging air from an air reduction electrode, and an electrolyte chamber between the fuel oxidation electrode and air reduction electrode equipped, respectively, with collector plates, wherein a slidable shutter plate with a plurality of through-holes formed therein is installed in the boundary section between at least one of the electrodes and the chamber adjacent thereto, being either the fuel chamber or air chamber, wherein the collector plates have the same number of through-holes as the shutter plate and have through-holes with a shape corresponding to the through-holes in the shutter plate, and wherein the collector plates are arranged so as to make contact with the shutter plate.

[0011] The shutter can be operated using a piezoelectric element, electromagnet, bimetal or shape-memory alloy distorted by hydraulics, electric motors, ultrasonic motors and voltage changes. The through-holes in the shutter plate and collector plate are several millimeters in diameter. The shutter plate can be made from a non-corrosive material, such as stainless steel or a fluorine resin. Sufficient control properties can be maintained so that the thickness is down to several millimeters.

[0012] In order to maintain the rigidity of the shutter plate, the shutter plate can be interposed between two porous collector plates.

[0013] [Operation and Effect of the Invention]

When the shutter plate slides, the opening area changes in the through-holes of the shutter plate and adjacent collector plate through which the fuel and air pass, and the amount of fuel supplied to the fuel reaction layer and the amount of air supplied to the air reaction layer can be controlled responsively. When the cell reaction stops, the opening area in the through-holes of the shutter plate and adjacent collector plate is reduced to zero, and the fuel does not disperse in the air reaction electrode via the electrolyte chamber.

[0014] By forming through-holes in the shutter plate and collector plate and changing the opening area between both sets of through-holes, the amount of fuel and air supplied can be controlled as desired, and the cell reaction can respond to load fluctuations.

[0015] Also, by reducing the open area between both sets of through-holes to zero when the cell reaction stops, the fuel disperses to the air reaction electrode side. This prevents a decline in cell performance and the generation of heat.

[0016] [Working Examples]

The following is an explanation of working examples of the present invention with reference to the drawings.

Working Example 1

A vertical cross-sectional view of a fuel cell 1 is shown in FIG 1. A lateral cross-sectional view of the fuel chamber side in FIG 1 is shown in FIG 2. Shutter plates 7 with through-holes 6 are installed for the fuel oxidation electrode 3 and the air reduction electrode 5, and collector plates 10 with through-holes 8 having the same pitch and area size as the through-holes 6 in the shutter plates 7 are installed for both electrodes.

[0017] An electrolyte chamber 12 is installed between the collector plates 10, 10 via a gas supply layer and reaction layer 11. The shutter plates 7, 7 can be moved vertically by a motor 16 (FIG 2) via a cam 15 in the fuel cell chamber 14. A one-way clutch 19 is installed on the connecting shaft 18 for the motor 16 and the cam 15 to rotate the cam 15 in one direction and to keep a shutter plate 7 in the same position when the motor 16 is turned off. By vertically moving a shutter plate 7, the opening area between the through-holes 6 in the shutter plate 7 and the through-holes 8 in the collector plate 10 can be changed. This allows the amount of methanol fuel or gas passing through to be controlled.

[0018] When the cell reaction stops, the opening area between the through-holes 6, 8 drops to zero. As a result, none of the fuel inadvertently passes through the electrolyte chamber 12 and disperses in the air reaction electrode 5. The ends of the shutter plate 7 are sealed against the fuel cell walls using a sealant. In the left half

of FIG 2, the through-holes are open. In the right half, the through-holes are closed.

[0019] Working Example 2

The fuel cell 1 in this working example is shown in FIG 3 and FIG 4. In this working example, a partitioning wall 23 with a plurality of through-holes 22 is formed in the boundary section between the fuel chamber 21 and the fuel oxidation electrode 3, and a rotatable shutter plate 25 supported by a central shaft is installed in the partitioning wall 23. The through-holes 26 in the shutter plate 25 have the same pitch and area as the through-holes 22 in the partitioning wall 23. An extended rack 27 on the shutter plate 25 is rotated by a pinion 30 driven by a motor 27.

[Brief Explanation of the Drawings]

[FIG 1] A cross-sectional view of the fuel cell in a working example of the present invention.

[FIG 2] A partial cross-sectional view from the front of the fuel cell in FIG 1.

[FIG 3] A cross-sectional view of the fuel cell in another working example of the present invention.

[FIG 4] A partial cross-sectional view from the front of the fuel cell in FIG 3.

[FIG 5] A detailed diagram of the electrodes in the fuel cell.

[Key to the Drawings]

3 ... Fuel Oxidation Electrode

5 ... Air Reduction Electrode

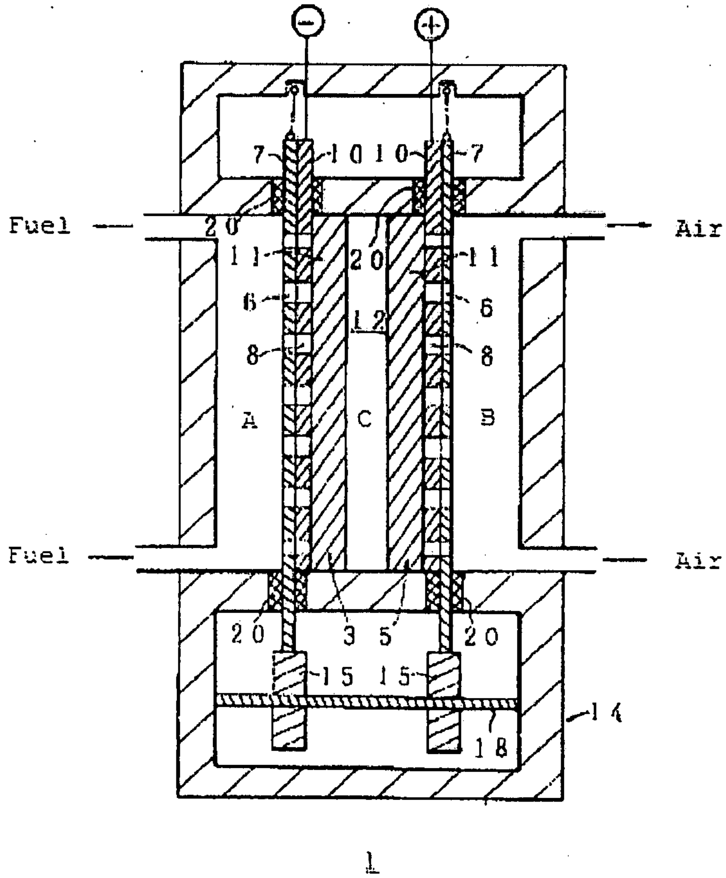
7 ... Shutter Plate

10 ... Collector

6, 8, 22, 26 ... Pores

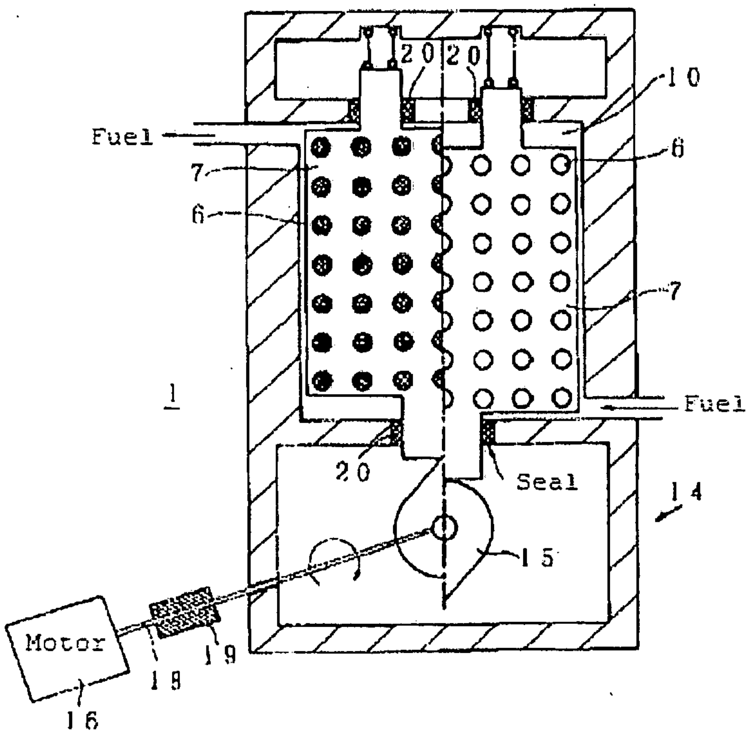
7, 25 ... Shutter Plate

[FIG 1]

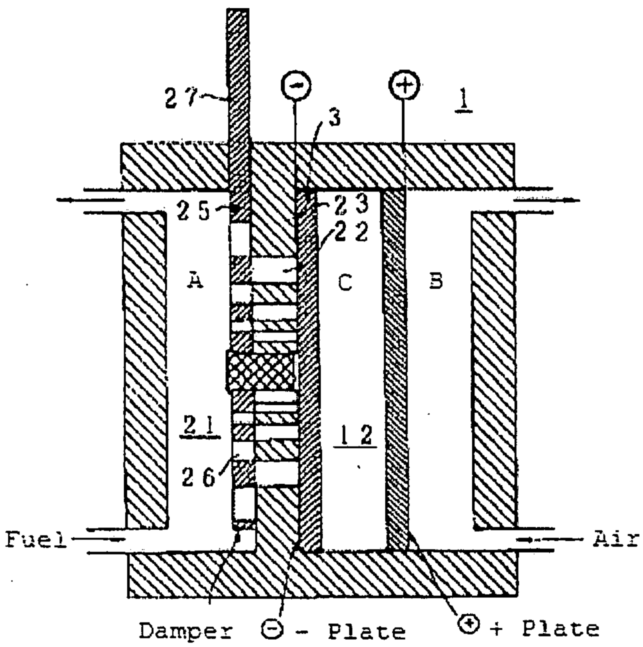


A: Fuel Chamber
B: Air Chamber
C: Electrolysis Chamber

[FIG 2]

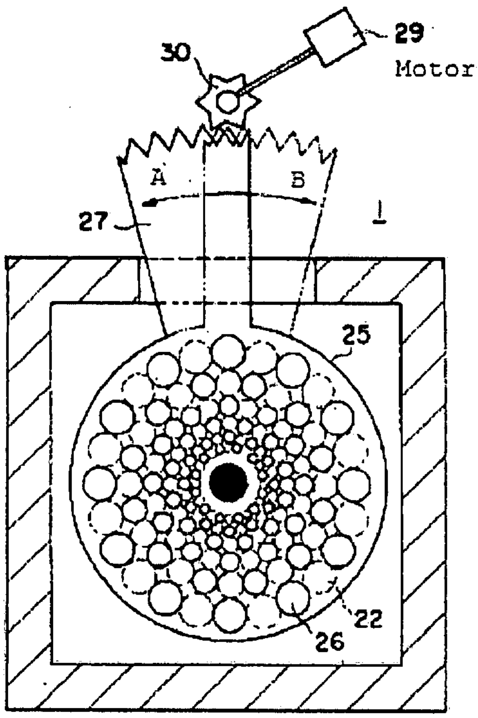


[FIG 3]



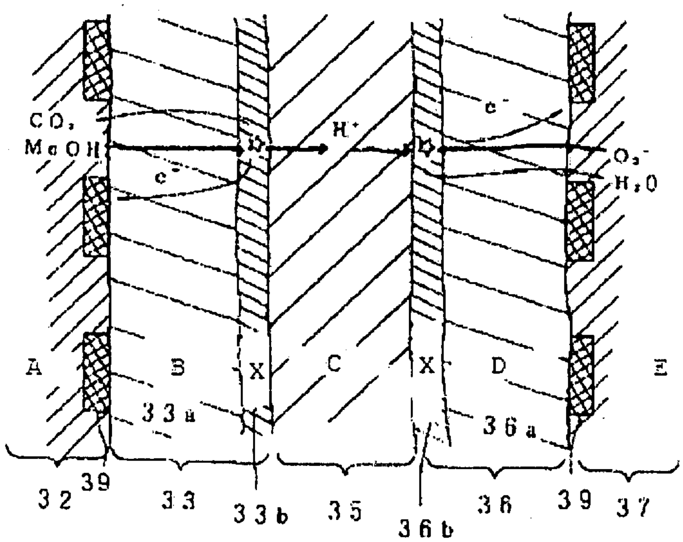
A: Fuel Chamber
B: Air Chamber
C: Electrolysis Chamber

[FIG 4]



A: Close
B: Open

[FIG 5]



A: Fuel Chamber
B: Gas Feed Layer
C: Electrolysis Chamber
D: Gas Feed Layer
E: Air Chamber
X: Reaction Layer